ECOLOGY AND THERMAL INACTIVATION OF MICROBES IN AND ON INTERPLANETARY SPACE VEHICLE COMPONENTS

Thirtieth Quarterly Report of Progress

Order No. W-13411

July 1, 1972 - September 30, 1972

Conducted by

Division of Microbiology - Cincinnati Research Laboratories
OS, Bureau of Foods
Food and Drug Administration

for the

National Aeronautics and Space Administration
Washington, D. C.

U. S. Department of Health, Education, and Welfare
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Abstract

The experimental sterilization facility at the Spacecraft Bioassay Laboratory, Cape Kennedy, Florida was developed to simulate conditions that will be encountered during terminal sterilization of space vehicles. The system consists of a temperature-controlled oven with a nitrogen gas stream containing a known concentration of water. Moisture analyzers are utilized to monitor the gas flowing over spore samples contained in the oven.

In its original configuration, no provision was made for the control of water vapor during the sterilization cycle. Because moisture profoundly influences the thermal inactivation of bacterial spores, an upper limit for the moisture content in the gas used to sterilize the space vehicle was established (25% RH at 0°C STP). Accordingly, a controller was developed and installed to provide these conditions in the experimental sterilization facility. This report is a description of this controller.

Equipment

Two cylinders of nitrogen gas maintained at a constant pressure of 7.5 psi are used as a carrier gas for the moisture. The gas stream from one cylinder is dried with $Mg(ClO_4)_2$ and is used for a reference gas whereas the second cylinder is used for increasing the water concentration in the gas stream. Figure 1 illustrates the complete system. The influent and effluent gas

is measured by a moisture monitor. This monitor is standardized with known weights of $Na_2(WO_4)_2 \cdot 2H_2O$ to assure accurate measurements. One-fourth-inch copper tubing is used throughout the system with the exception of influent and effluent sample gas. At this point, 1/8-inch tubing is used.

Experimental

After measuring the nitrogen background moisture, approximately 10 ppm, the No. 2 nitrogen tank is turned on, and the effluent flow from the sample is adjusted to 100 cc/minute. The level is increased by bubbling the No. 2 gas stream through the water bottle, which is held at a constant temperature of 21°C by the water bath. This temperature was chosen to assure an optimum water level for a minimum flow from the No. 2 gas stream.

Flow is a critical feature in this method, for it is used as a fine vernier in reaching the desired moisture concentration. As shown in Figure I, the water level is attained by a combination of three adjustments: 1) the temperature of the water bath, 2) the flow through the water bottle, and 3) the flow from the sample container.

To properly adjust the flow and to maintain a stable water level, the sample effluent should be adjusted first. The rule seems to be--the faster the flow rate, the more stable the desired level becomes. The next and final adjustment is the flow through the water bottle inasmuch as the water bath temperature

is arbitarily controlled at 21°C. This is accomplished by slowly closing the water-bottle valve until the moisture monitor reaches the proper level.

During the development of the flow-through apparatus, the container in which the spores are exposed had to be altered so that the gas could easily purge the cans for multiple runs. The Cincinnati Laboratory oven shown at the bottom of Figure 1 represents the tin cans as they are changed for the flowing exposures. The can lid with its fittings and septum is autoclaved and dried with the rest of the can before the spores are placed into cups and loaded into the trays. The cans are sealed in a low moisture atmosphere (5% RH at 30°C) and transferred to the oven at room temperature. Multiple-can runs are hooked in a series, i.e., the effluent gas from one can becomes the influent gas of the next can. This is achieved by using 1/8-inch "U" shaped copper tubing with hypodermic needles soldered to each end.

All cans are purged to background nitrogen moisture previous to each run. When this is accomplished, the moisture level is raised and stabilized, after which the temperature of the oven is calibrated. Come-up time for the oven is approximately 30 minutes for 113°C.

Results

Moisture content in a flowing gas stream may be regulated using the device described above. A moisture concentration of

1.3 μg/ml has been controlled successfully for durations of 15 and 30 hours, respectively. Variations of no more than 100 ppm representing ± 0.08 μg/ml were achieved.

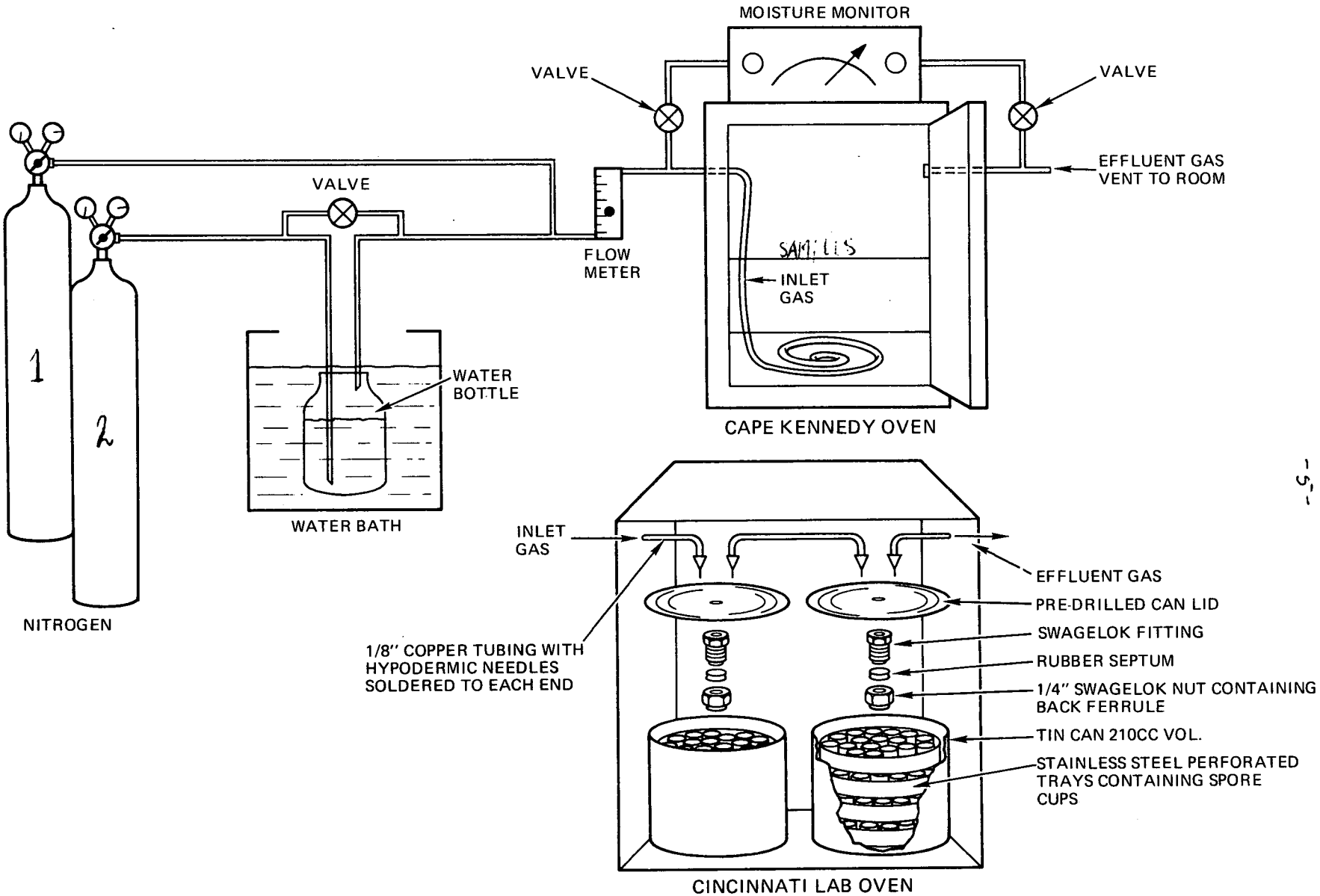
MOISTURE MONITOR
VALVE
VALVE
EFFLUENT GAS
VENT TO ROOM
VALVE
FLOW
METER
SAMPLES
INLET
GAS
1
2
WATER
BOTTLE
WATER BATH
CAPE KENNEDY OVEN
NITROGEN
INLET
GAS
EFFLUENT GAS
PRE-DRILLED CAN LID
SWAGELOK FITTING
RUBBER SEPTUM
1/4" SWAGELOK NUT CONTAINING
BACK FERRULE
TIN CAN 210CC VOL.
STAINLESS STEEL PERFORATED
TRAYS CONTAINING SPORE
CUPS
1/8" COPPER TUBING WITH
HYPODERMIC NEEDLES
SOLDERED TO EACH END
CINCINNATI LAB OVEN

FIGURE 1